Received: 12 August 2022 | Accepted: 5 April 2023

DOI: 10.1002/jeab.854

RESEARCH ARTICLE

Journal of the Experimental Analysis of Behavior

SEAB

Relating relational networks: An initial experimental analysis

Cainã T. Gomes[1,5] | William F. Perez[1,2] | Dermot Barnes-Holmes[3] | Colin Harte[1,2,4]

[1]Instituto Par – Ciências Comportamento, São Paulo, Brazil

[2]Instituto Nacional sobre Comportamento, Cognição e Ensino (INCT-ECCE), Brazil

[3]Ulster University, Northern Ireland

[4]Universidade Federal de São Carlos, Brazil

[5]Universidade de São Paulo, Brazil

Correspondence
Cainã T. Gomes, Universidade de São Paulo, Brazil.
Email: caina@usp.br

Funding information
Conselho Nacional de Desenvolvimento Científico e Tecnológico, Grant/Award Numbers: 573972/2008-7, 465686/2014-1; Fundação de Amparo à Pesquisa do Estado de São Paulo, Grant/Award Numbers: 2016/05935-6, 2017/10037-0, 2008/57705-8, 2019/24210–0

Editor-in-Chief: Mark Galizio
Handling Editor: Karen Lionello-DeNolf

Abstract

Studying relating of relational networks is a complex and challenging task. The main objective of the present study was to demonstrate relating within and across relational networks based on same/opposite and bigger/smaller contextual cues and establish antecedent control. After nonarbitrary pretraining of the contextual cues, two nonsense stimulus classes were established based on comparative relations. Participants were trained to select stimuli from an array of options based on a symbolic rule that established a relation between two stimuli: one of Network 1 and one of Network 2. Training involved relating Network 1 to Network 2, and testing assessed relating Network 2 to Network 1. Seven of eight participants reached the mastery criterion in training and responded accordingly in test. In a final stage, reinforcing and punishing consequences were varied systematically in the presence of two novel stimuli and antecedent control was observed for all 7 participants. Experiment 2 replicated the results of Experiment 1 but using contextual cues taken from natural language, and Experiment 3 sought to understand the effects of pretraining relational responding using natural language. The mastery criteria were reached by four of seven participants in Experiment 2 and by all eight participants in Experiment 3. Future studies could develop and refine the methods employed here in analyzing the relating of relational networks, thus allowing for an increasingly sophisticated behavior-analytic account of human language and cognition.

KEYWORDS

derived stimulus relations, relational frame theory, rule-governed behavior, verbal behavior

Relational frame theory (RFT; Hayes et al., 2001) as a behavior-analytic account of human language and cognition has attracted increasing attention over the last 20 years (see Dymond & Roche, 2012; Hughes & Barnes-Holmes, 2016). The core analytic unit of the relational frame (i.e., a simple relational network) was defined as possessing three properties: mutual entailment (if A is related to B, then B is also related to A), combinatorial entailment (if A is related to both B and C, then B and C are also related), and the transformation of stimulus functions (the functions of the related stimuli are transformed based on the types of relations in which those stimuli are involved). The third property—the transformation of functions—ensured that the concept of the relational frame would always refer to some change or modification in the behavioral functions of the framed stimuli that extended beyond their relational functions per se. For example, if A was less than B and B was less than C in a particular instance of relational framing and a reinforcing function was attached to A, then C may acquire a greater reinforcing function than A or B (see Dougher et al., 2007, for relevant supporting experimental evidence). The concept of a relational frame was thus designed to capture how human language and cognition changes responses to the "real" world rather than simply providing, for example, an analysis of logical or abstract human reasoning.

According to RFT, a rule or instruction may be thought of as a more complex network than that of a single frame, typically involving multiple frames of coordination (e.g., equivalence) and conditionality (e.g., if/then) with contextual cues that transform specific behavioral functions (e.g., Barnes-Holmes et al., 2001). Take, for example, a simple instruction such as "If the light is red, then stop." This rule involves frames of coordination between the words *light*, *red*, and *stop*, and the actual light, color red, and the act of stopping, respectively. Additionally, a conditional relation between the red light and the act of stopping is established by the contextual cues *if* and *then* (i.e., first red light, then stop). The relational network thus transforms the functions of the red light itself such that it now controls the act of "stopping" whenever an individual who was presented with the rule observes the red light.

Additional conceptual developments in RFT generated experimental and applied analyses of verbal rules or instructions in terms of complex relational networks composed of multiple relational frames (e.g., O'Hora et al., 2004, 2014; see Zapparoli et al., 2021, for a recent overview of the operant analysis of rule governance within RFT). In addition, analogical and metaphorical reasoning has been interpreted in terms of relating relational frames (e.g., Barnes et al., 1997). To illustrate, consider the example of an analogy: *Pear is to peach as cat is to dog*. In this example, there are two relations coordinated through class membership (controlled by the cue *is to*) and a coordination relation that links the two coordination relations (controlled by the cue *as*). From an RFT point of view, analogical reasoning thus involves the same behavioral process involved in relational framing more generally but applied to relational framing itself (see Stewart & Barnes-Holmes, 2004). At an even more complex level, RFT has argued that relating relational networks to other relational networks may provide a functional-analytic understanding of the behaviors involved in complex verbal comprehension and problem solving. Consider an example provided by Barnes-Holmes et al. (2017):

> [F]or illustrative purposes we will consider a hierarchical network containing four relational networks with contextual cues controlling the relating of the three "lower-level" networks to each other. First, the "stories" or networks of Martin Luther King Jr., Malcom X, and Mahatma Ghandi may be hierarchically related to the superordinate network, "Famous Civil Rights Campaigners". Second, the relations among the three subordinate networks may differ depending upon contextual cues provided by specific parts of those three networks. For instance, Martin Luther King and Malcolm X may be coordinate with each other, and distinct from Ghandi, in the context of "African-American civil rights campaigners", but King and Ghandi may be coordinate with each other, and distinct from Malcolm X, in the context of "advocates of nonviolent resistance." (p. 440)

As highlighted by Barnes-Holmes et al., despite the apparent simplicity of this example to a verbally sophisticated adult reader, the relational activity involved in this case actually requires a high level of relational complexity and involves many subtleties in contextual control.

Researchers in RFT have recently offered what they describe as a hyperdimensional, multilevel framework for analyzing the dynamics of derived relational responding (see Barnes-Holmes et al., 2017, 2020; Barnes-Holmes & Harte, 2022). According to this framework, relational responding may be conceptualized as developing in a broad sense from (a) mutual entailment to (b) simple networks involved in frames to (c) more complex networks involved in rules and instructions to (d) the relating of relations involved in analogical reasoning, and finally to (e) relating relational networks, which is typically involved in complex problem solving. Lower levels (e.g., mutual entailing) are seen as containing patterns of relational responding that may provide an important learning history for the patterns of relational responding that occur in the levels above (e.g., relational framing). In general, the different levels are based on a combination of well-established assumptions within RFT and, where possible, empirical evidence. Critically, Barnes-Holmes et al. (2017) concluded that there was published empirical evidence for each of the first four levels of the framework (see also Hughes & Barnes-Holmes, 2016, for a recent review of this work) but "were not aware of any published basic research studies in RFT that had demonstrated the relating of complex relational networks in laboratory settings" (p. 440). The general objective of the research reported in the current article is to begin that work.

Studying the relating of relational networks is, by definition, a complex and challenging task and could involve many different general strategies. Thus, what we offer here should not be seen as *the* way but as only one way in which we might proceed. To simplify the strategy adopted in the current research, it seems wise to provide a "real-world," albeit relatively contrived, example of the model we intend to develop here. First, imagine you were introduced to eight siblings, four brothers and four sisters, and you were required to organize the two sets of siblings according to relative age. The four brothers might be labeled 1, 2, 3, and 4, with 1 indicating the youngest brother and 4 the eldest, and the four sisters labeled 6, 7, 8, and 9, with 6 indicating the youngest and 9 the eldest. Now imagine that you are required to learn the name of each of the eight siblings. Once the names have been learned, two separate comparative relational networks have been established (i.e., the names for the brothers, 1, 2, 3, and 4 and the names for the sisters, 6, 7, 8, and 9). Critically, the two networks may be seen as separate rather than one single network because the position of the individuals in one network are not defined relative to the position of the individuals in the other network. Thus, for example, Brother 1 could be 49 years old and Sister 6 could be 21 years old; in this case Brother 1 is older than Sister 6, but they are coordinated in terms of their relative position within their two networks (i.e., they are clearly different in age but similar in terms of their relationship to their same-sex siblings).

Imagine that you are also required to learn what each of the siblings does for a living, but part of acquiring this information involves relating across the two networks. For example, sometimes, you are simply told that Brother 1 is a fireman, and thus when asked who the fireman is, you name Brother 1. On other occasions, however, you are told that the sister who is opposite in age to Brother 4 (the eldest brother) is a police officer and asked who is the police officer in the family. In this case, therefore, you are required to name Sister 6 (the youngest sister).

Having learned to relate within and across the two sibling networks (from Network 1 to Network 2), you should be able to relate within and across the networks in the other direction (i.e., from Network 2 to 1) using novel information about the siblings, in the absence of any additional training. For example, imagine you are told that Sister 9 owns a Harley Davidson motorcycle; when asked which sibling owns a Harley, you would name Sister 9. If you were told the brother who is opposite in age to Sister 9 (the eldest) owns a holiday home in France, you would name Brother 1 (the youngest) when asked who owns property in France. Finally, relating within and across the relational networks could be brought under antecedent control. Thus, for example, if you are told that the brother who is opposite in age to Sister 8 (the second eldest) is the only married brother and you were asked to name any brother who is *not* married, naming Brothers 1, 3, or 4 would be correct (because Brother 2 is the second-youngest brother and therefore opposite to the second-eldest sister).

In line with this perspective, three experiments were designed to attempt to demonstrate this phenomenon in a lab setting. The experiments reported here attempted to model this type of relating within and across networks and the antecedent control, as outlined above.

EXPERIMENT 1

Experiment 1 sought to train and test the patterns of relational responding described above, including relating within and across relational networks, using the contextual cues "same" and "opposite," which were pretrained in the experiment. The pretraining for the contextual cues was broadly similar to that reported by Steele and Hayes (1991).

Method

Participants

Eight undergraduate students (four male and four female) volunteered to take part in the study. The participants were aged between 19 and 25 years and were recruited through personal contacts from a variety of degree programs, including psychology ($n = 2$). Before the experiment began, participants read a consent statement with information about the research. At the end of the experimental sessions, participants were fully debriefed about the goals of the experiment. They received no payment or compensation for their participation.

Materials, apparatus, and stimuli

The experimental sessions took place in a 3- × 4-m room equipped with a table, chair and laptop computer (Hewlett Packard Pavilion 14-V066BR). Software written in Visual Basic 6.0 presented stimuli, delivered consequences, and recorded participant responses. During training trials, programmed consequences for responses deemed correct consisted of presenting the word "Correct" in the middle of the computer screen and a "happy jingle" for 1 s; for responses deemed incorrect, the word "Wrong" appeared with a "sad jingle" for 1 s. The duration of experimental sessions for each participant lasted (approximately) between 100 to 130 min. All the stimuli[1] employed across Experiments 1 and 2 are grouped together based on how they were used in the Experiments (see Procedure below). These specific stimuli are computer generated 3D images brightly colored and textured and were chosen so as to be (in principle) abstract and meaningless to the participants.

Procedure

Phase 1. Same and opposite simple nonarbitrary relational training and testing

This phase was intended to establish contextual control functions for two arbitrary stimuli—the relational function of "same" for one stimulus and the relational function of "opposite" for the other stimulus. The contextual cues were two pseudowords "VEK" and "TOJ." These stimuli were randomly assigned as "same" or "opposite" for all participants; no differential results were found. The training and testing are referred to as "simple" because the trials involved presenting stimuli that differed in terms of relatively basic perceptual properties (e.g., long vs. short lines). Once a participant was seated in front of the computer, the following instructions were presented on screen to initiate the training and testing:

> One figure will appear on the top of the screen, then another figure will appear in the middle of the screen, followed by three other figures on the bottom part of the screen.

[1]Stimulus images courtesy of Michael J. Tarr, Center for the Neural Basis of Cognition and Department of Psychology, Carnegie Mellon University, http://www.tarrlab.org/. The choice of these stimuli was purely arbitrary.

> For every trial, there is one correct answer. To select one of the three options on the bottom, you must click on the option with the pointer.
> Whenever you choose the correct option, your choice will be followed by a happy tune and the word “CORRECT,” and if you choose the incorrect option, your choice will be followed by a dissonant sound and the word “WRONG.”
> There will be a time, later, when the computer won’t tell you if your response was correct or not. When that happens, keep going based on what you learned before. The computer will keep registering your correct and incorrect responses.

The contextual cues that were to be established as functionally equivalent for “same” and “opposite” were presented at the top of the screen, followed 1.5 s later by the presentation of a sample and 1.5 s later by three comparison stimuli. The comparison stimuli appeared from left to right along the bottom edge of the screen; the left, middle, and right locations of the three stimuli were randomized across trials. In this phase, the sample and comparisons were related to each other along a physical dimension. For example, the sample could be a short line with the three comparisons consisting of a short line, a medium-length line, and a long line (see Figure 1, top panel). If this configuration of stimuli was presented on a given trial and the contextual cue for SAME was presented, picking the short-line comparison was reinforced; if the cue for OPPOSITE was presented, picking the long-line comparison was reinforced. Choosing the middle-length line was always punished. Twelve different sets of stimuli were presented during this phase to train the relational functions for the SAME and OPPOSITE cues. In each case, either the SAME or OPPOSITE cue appeared at the top of the screen with one of the two stimuli from the ends of the three-stimulus continuum. When the cue for SAME was presented, choosing the comparison that was the same as the sample was always reinforced, and when the cue for OPPOSITE was presented, choosing the comparison that was at the other end of the continuum was reinforced. All other responses were punished. On each trial, when a participant emitted a response, the appropriate feedback was presented and the screen cleared for an intertrial interval of 1.5 s. The 12 stimulus sets were presented in a random sequence until participants emitted 24 consecutively correct responses.

When participants successfully completed the training, the screen cleared, and the following instruction appeared on screen: “On this next block, the computer won’t provide any feedback—keep responding based on what you learned before.” A set of six novel stimulus sets was then presented to participants to determine whether the SAME and OPPOSITE contextual cues controlled the predicted relational responding in the absence of programmed differential feedback (i.e., after each response, the program progressed directly to the 1.5-s intertrial interval). The six sets of stimuli were presented in a random sequence for 72 trials. Participants were required to produce a minimum of 65 correct responses across the 72 trials to continue to the next phase of the experiment.

Phase 2. Same and opposite complex arbitrary relational training and testing

Phase 2 continued to train and test the same contextual cues for SAME and OPPOSITE using sets of stimuli that differed along a same–opposite continuum (see Figure 1). However, the abstraction of that continuum by participants likely required extended histories of arbitrarily applicable relational responding within the wider verbal community. For example, if the sample was a white flag, then the correct comparison in the presence of the SAME cue was a picture of a hippy rather than a picture of soldiers engaged in combat. Thus, for participants to make the correct choice in this phase, they would have to have learned, preexperimentally, that a white flag was coordinated with “peace” or “surrender,” whereas soldiers pictured in combat would be in an opposition relation with those verbal stimuli. For this reason, the training and testing is described as “complex.” Phase 2 was therefore similar to Phase 1, except that the “complex” sets of stimuli presented were used for training (Sets 1–12) and testing (Sets 13–18). Once again, participants were required to produce 65/72 correct responses in the test block to progress to the next phase.

Phase 3. Establishing direct function to the eight colorful stimuli

The objective of this phase was to establish the discriminative control of eight presumably meaningless stimuli over key-pressing responses. The phase commenced with the following instructions presented on the computer screen:

> Several figures will appear on the top of the screen one at a time, and your objective is to figure out which key to press in each trial. For every figure, there is a corresponding key. The keys available are the keys corresponding to the numbers 1 to 9, except for key 5. The computer will tell you if your responses are correct or not.

The trial started with the presentation of one of the eight colorful stimuli presented in Panel 3 of Figure 1. One of these stimuli appeared at the top of the screen, and pressing one of the eight keys on the computer keyboard, 1–4 or 6–9, produced the corrective feedback (as described previously). The Keys 1–4 and 6–9 were used as response keys (with 5 being inoperative) because

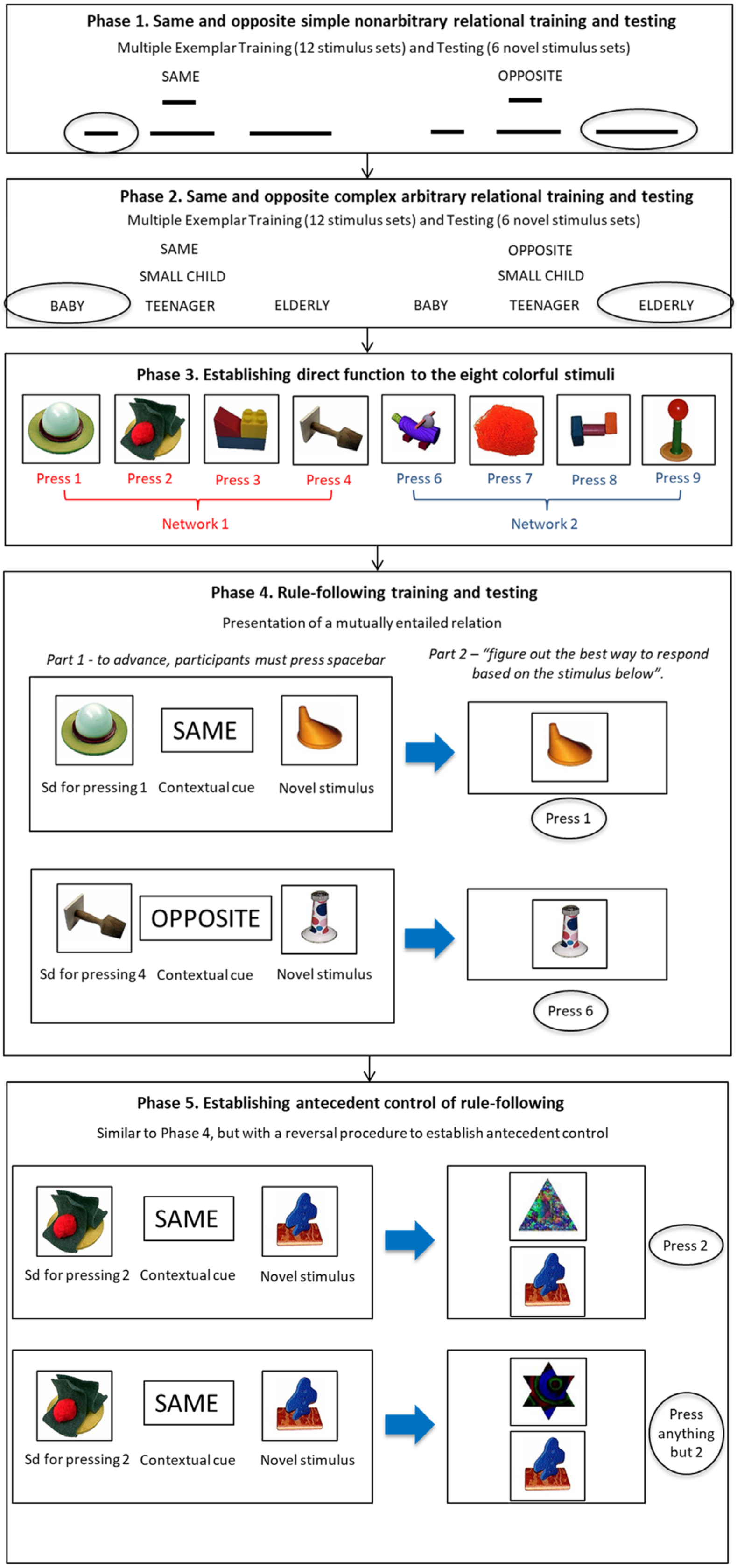

FIGURE 1 Diagrammatic representation of the five phases of Experiment 1. The figures on rectangular frames are representative of the tasks that appeared on the computer screen. The experimenter-designated correct choice is indicated by a circle. For the sake of clarity, contextual cues are denoted by the English words "SAME" and "OPPOSITE." However, these were not presented in the actual experiment; rather, nonsense words ("TOJ" and "VEK") served as the contextual cues for these functions.

this created a context in which two separate relational networks (i.e., 1–2–3-4 and 6–7–8-9) could be related to each other during subsequent phases of the experiment. We chose to use number keys exactly because we wanted to draw upon previous bigger/smaller relations.

The eight stimuli were presented randomly from trial to trial and the trials continued until a participant emitted 24 consecutively correct responses. In effect, participants had to learn the eight stimulus–number relations through trial and error. Participants progressed to the next phase immediately after producing 24 consecutively correct trials.

Phase 4. Relating relational networks

Phase 4 was divided into two stages. The first stage sought to train relating from Network 1 to Network 2, and the second sought to test subsequent derived relating from Network 2 to Network 1.

Stage 1. Training relating from Network 1 to Network 2. During this stage of Phase 4, participants were trained to respond within Network 1 (Keys 1–4) if the SAME cue was presented. If the OPPOSITE cue was presented, participants responded within Network 2 (Keys 6–9), but the response involved relating across the two networks in a manner that reflected the opposite continuum itself. For example, if the cue for SAME was presented with the stimulus for pressing the 1 key and a novel stimulus, participants were required to press the 1 key. If, however, participants were presented with the OPPOSITE cue with the stimulus for pressing the 1 key and a novel stimulus, they were required to press the number 9 key because it was in Network 2 and at the opposite end of the continuum for that network (i.e., opposite to number 6). In effect, the objective of this stage was to train participants to relate across relational networks by responding to novel stimuli based on a mutually entailed relation between two stimuli: one with a direct history of reinforcement and one stimulus without a direct history of reinforcement.

Each trial during this stage was presented in two parts, which we will refer to as Part 1 and Part 2 (see Figure 1, panel 4). The following instruction appeared at the top of the computer screen for Part 1:

> Some symbols are appearing below. Your objective is to figure out the best way to respond in each trial, based on the message codified in this instruction composed by these symbols. After reading the instruction, press spacebar to continue.

Immediately below the instruction, two stimuli appeared, one with a direct history of reinforcement (from Phase 3) and a second with no such history. The first stimulus always appeared on the left, and the second stimulus always appeared on the right, with a contextual cue SAME or OPPOSITE (presumably nonsense pseudowords) appearing between the two stimuli. When participants pressed the spacebar, the computer screen cleared and the second part of the trial was presented 1.5 s later. The following instruction appeared at the top of the screen, "Figure out the best way to respond based on the stimulus below," and the second stimulus (the one without a direct history of reinforcement) was presented in the center of the screen. The instruction and stimulus remained on screen until the participant pressed one of the eight response keys from Phase 3 (i.e., 1–4 and 6–9). Each key press was reinforced or punished with the programmed feedback (i.e., "Correct" or "Wrong" with the "happy" or "sad" jingle, respectively).

The eight responses that were reinforced were as follows: Key Stimulus 1/SAME cue/Novel Stimulus 1 = press Key 1; Key Stimulus 2/SAME cue/Novel Stimulus 2 = press Key 2; Key Stimulus 3/SAME cue/Novel Stimulus 3 = press Key 3; Key Stimulus 4/SAME cue/Novel Stimulus 4 = press Key 4; Key Stimulus 1/OPPOSITE cue/Novel Stimulus 1 = press Key 9; Key Stimulus 2/OPPOSITE cue/Novel Stimulus 2 = press Key 8; Key Stimulus 3/OPPOSITE cue/Novel Stimulus 3 = press Key 7; and Key Stimulus 4/OPPOSITE cue/Novel Stimulus 4 = press Key 6. All other responses were punished. The eight different trials were presented in a random sequence. To proceed to Stage 2, participants were required to produce 24 consecutively correct responses.

Stage 2. Testing relating from Network 2 to Network 1. This stage was similar to Stage 1, except that the S^Ds for Keys 6–9 were presented with novel stimuli and responding within Network 2 (Keys 6–9), if the SAME cue was presented, was deemed correct; if the OPPOSITE cue was presented, responding within Network 1 (Keys 1–4) but relating across the two networks in a manner that reflected the opposite continuum was deemed correct. The stimuli used as Networks 1–4 and 6–9 were counterbalanced across experiments so that there were no idiosyncrasies that differentially affected results. The eight responses deemed correct were as follows: Key Stimulus 6/SAME cue/Novel Stimulus 6 = press Key 6; Key Stimulus 7/SAME cue/Novel Stimulus 7 = press Key 7; Key Stimulus 8/SAME cue/Novel Stimulus 8 = press Key 8; Key Stimulus 9/SAME cue/Novel Stimulus 9 = press Key 9; Key Stimulus 6/OPPOSITE cue/Novel Stimulus 6 = press Key 4; Key Stimulus 7/OPPOSITE cue/Novel Stimulus 7 = press Key 3; Key Stimulus 8/OPPOSITE cue/Novel Stimulus 8 = press Key 2; and Key Stimulus 9/OPPOSITE cue/Novel Stimulus 9 = press Key 1. The eight different trials were presented in a random sequence. Critically, no programmed consequences were presented during Stage 2 (i.e., the computer screen simply cleared after each response for 1.5 s before the next trial was presented). To successfully complete Stage 2 and proceed to the next phase, participants were required to produce a minimum of 28 correct responses across a single block of 32 testing trials.

Phase 5. Establishing antecedent control of relating relational networks

The objective of this phase was to establish antecedent control over the performances established during Phase 4 (see Figure 1, Panel 5). Specifically, this phase was similar to Stage 2 of Phase 4, except that during Part 2 of each trial, one of two stimuli (S+ or S-) appeared on the top of the computer screen with the "novel" stimulus below it. On the trials when an S+ appeared with the novel stimulus, participants were required to emit the same response that was emitted during Phase 4. However, on the trials when an S- appeared with the novel stimulus, emitting any response except the reinforced response during Phase 4 was required. For example, if Key Stimulus 2/SAME cue/Novel Stimulus 2 appeared followed by S- /Novel Stimulus 2, then pressing any available key other than Key 2 was reinforced.

The five stages were presented in the following sequence: (5.1) baseline, (5.2) training S1 as S+ and S2 as S-, (5.3) Unreinforced Probes 1, (5.4) training S1 as S- and S2 as S+, and (5.5) Unreinforced Probes 2. Only the transition between training and probes was signaled with the preliminary instruction.

5.1 Baseline. In this stage, S1 or S2 stimuli were presented but no differential consequences were arranged for responding to them. With the introduction of the S+ and S- stimuli, there were now 16 different trials that could be presented to the participants (i.e., the same 16 trials from Phase 4). This stage involved 32 trials presented in a random sequence; S1 was presented on 16 trials and S2 was presented on the remaining 16 trials.

5.2 Training S1 as S+ and S2 as S-. In this stage, differential consequences were presented for responses in the presence of the S1 and S2 stimuli. If S1 was presented, the reinforcement contingencies were the same as during Phase 4, Stage 1 (i.e., responding in accordance with the rule); if S2 was presented, the reinforcement contingencies were reversed. The 32 different trials were presented randomly until participants emitted 12 consecutively correct responses.

5.3 Unreinforced Probes 1. The procedure for this stage was the same as for Stage 5.1. Before this stage started, participants received the following instruction: "In this next phase, the computer won't provide you with any feedback for your responses."

5.4 Training S1 as S- and S2 as S+. This stage was similar to Stage 5.2 except that the previous S+ now functioned as an S- and the previous S- now functioned as an S+. For example, if the triangle was employed as S+ on Stage 5.2, then the same triangle would be assigned as S- on this stage.

5.5 Unreinforced Probes 2. This procedure and instructions for this stage was the same as for Stage 5.1 and Stage 5.3.

Results and discussion

The results of the first four experimental phases are summarized in Table 1. All participants reached the mastery criterion in both nonarbitrary (Phase 1, mean trials to criterion was 79, range: 30–145) and arbitrary (Phase 2, mean trials to criterion was 48, range: 24–105) same and opposite pretraining and performed successfully in the corresponding testing phase. Likewise, all participants reached the mastery criterion in the direct function training (Phase 3). All participants completed the relating relational networks phase within a range of 28 to 109 trials to reach the mastery criterion and produced the predicted performances in the testing phase, with a minimum of 29 correct responses in 32 testing trials.

Table 2 shows individual participants' performances in the final experimental conditions that sought to establish antecedent control of relating relational networks (Phase 5). During baseline training, one of the stimuli (S1) was arbitrarily designated as S+. All participants kept responding consistently with Phase 4; therefore,

TABLE 1 Results during Phases 1 to 4 (Experiment 1)

Part	Phase 1.1 Same/opposite nonarbitrary pretraining	Phase 1.2 Same/opposite nonarbitrary test	Phase 2.1 Same/opposite arbitrary pretraining	Phase 2.2 Same/opposite arbitrary test	Phase 3 Direct function training	Phase 4.1 Relating relational networks training	Phase 4.2 Relating relational networks test
P1	141	72/72	24	68/72	123	109	29/32
P2	50	67/72	77	71/72	53	40	32/32
P3	85	72/72	105	70/72	171	102	30/32
P4	39	72/72	24	72/72	219	32	31/32
P5	78	72/72	73	72/72	88	28	32/32
P6	30	72/72	24	69/72	115	81	31/32
P7	65	72/72	24	72/72	220	39	32/32
P8	145	71/72	36	66/72	73	33	31/32

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials are presented.

TABLE 2 Results of Phase 5: Establishing antecedent control of relating relational networks (Experiment 1)

Participants	5.1 Baseline	5.2 S1 as S+ and S2 as S-	5.3 Test 1	5.4 S1 as S- and S2 as S+	5.5 Test 2
P1	16/32	38	29/32	21	29/32
P2	16/32	13	32/32	15	31/32
P3	16/32	109	30/32	36	30/32
P4	17/32	19	31/32	15	32/32
P5	16/32	38	30/32	35	32/32
P6	17/32	32	32/32	14	32/32
P7	17/32	-	-	-	-
P8	15/32	118	32/32	17	31/32

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented. The symbol "-" in the table indicates that the participant in question did not reach the mastery criterion in the previous phase and was thus excluded from the study.

performance was near 50% correct, suggesting that neither S1 nor S2 had an effect on the participants' performances, given that responding was consistent with Phase 4. This suggests that the images chosen did not possess any discriminative functions for differential responding on this task for participants at this point. On the following subphase, the antecedent control of S1 and S2 over relating relational networks was successfully established for seven of eight participants, requiring between 13 and 118 trials to meet the mastery criterion; P7 left the study for not achieving the mastery criterion after 256 trials. The remaining seven participants produced the predicted performances in the first test with a minimum of 29 correct responses in 32 trials. Next, during baseline reversal, all participants rapidly reached the mastery criterion within 15–36 training trials. In the final test, all seven participants again produced the predicted performances.

Overall, seven of the eight participants progressed successfully through all of the experimental tasks that were designed to produce relating within and across four-member relational networks in terms of "same" and "opposite" relations. Participants were initially trained to relate from Network 1 to Network 2 and were then tested for derived relational responding from Network 2 to Network 1. Subsequently, the relating within and across relational networks was successfully brought under antecedent control.

Experiment 1 involved establishing the functions of "same" and "opposite" for two arbitrary stimuli, using procedures similar to those employed in previously published RFT research. In contrast, Experiment 2 sought to replicate the results of Experiment 1 but by using stimuli for SAME and OPPOSITE taken directly from natural language. The primary purpose of employing natural language stimuli was to test the implicit assumption that they would have functional properties similar to those of relational contextual cues that are pretrained in the laboratory. Although one might expect to find close functional overlap, the behavioral histories for words in natural language may lack the specificity of relational cues that are pretrained experimentally. For example, when a cue contextual for opposite is pretrained in the laboratory, it typically involves responding along a continuum (e.g., from small to medium to large). In contrast, the word "opposite" in natural language may be used in a more dichotomous manner as in, for example, two individuals sitting opposite to each other. In this sense, therefore, the use of natural language stimuli in Experiment 2 may be seen as a largely exploratory exercise.

EXPERIMENT 2

The purpose of Experiment 2 was to determine whether stimuli that had acquired their relational functions through the contingencies operating in the natural language environment would function in a manner similar to that of the contextual cues "SAME" and "OPPOSITE" that were established in Experiment 1. Therefore, the contextual cues used in the relating relational networks training and testing were the Portuguese equivalent to "it's the same as" and "it's the opposite of" (respectively, "é o mesmo que" and "é o oposto de").

Method

Participants

Eight undergraduate students (five male and three female), attending different universities in the city of São Paulo, volunteered to take part in the study. The participants were aged between 21 and 26 years and were recruited through personal contacts from a variety of degree programs, including psychology ($n = 2$). They received no payment or compensation for their participation.

Materials

The materials, setting, and stimuli were similar to those employed in Experiment 1, except that instead of using nonsense syllables as contextual cues for SAME and OPPOSITE, the Portuguese words for "it's the same as" and "it's the opposite of" were employed in the equivalent of Phases 4 and 5 from Experiment 1.

Procedure

The procedure for Experiment 2 was similar to that for Experiment 1, except that Phases 1 and 2 were removed (i.e., pretraining the relational functions for the contextual cues, SAME and OPPOSITE). In effect, Experiment 2 commenced with Phase 3 of Experiment 1.

Results and discussion

The results of the first two experimental phases are summarized in Table 3. All participants reached the mastery criterion in direct function training (the mean for trials to criterion was 116, range: 85–159). All participants completed the relating relational networks training phase (the mean for trials to criterion was 88, range: 25–187). Seven of eight participants produced the predicted performances in the testing phase, with a minimum of 29 correct responses in 32 testing trials. One participant, P14, failed to produce any correct responses. An analysis of the individual responses of this participant revealed a consistent pattern of errors: Unlike the other participants, in all trials in which the contextual cue was SAME, P14 pressed Keys 1, 2, 3 or 4, but when the contextual cue was OPPOSITE, Keys 6, 7, 8, or 9 were pressed. It appears, therefore, that P14 continued to relate Network 1 to Network 2 (as required during the training phase) but failed to relate Network 2 to Network 1 during the testing phase. Having failed to meet the test criteria, he was dismissed from the experiment, and thus Phase 2.2 continued with seven participants.

TABLE 3 Results during Phases 1 and 2 (Experiment 2)

Participants	Phase 1 Direct function training	Phase 2.1 Relating relational networks training	Phase 2.2 Relating relational networks test
P9	159	187	31/32
P10	103	136	31/32
P11	118	136	29/32
P12	136	25	32/32
P13	117	74	31/32
P14	97	71	0/32
P15	85	34	32/32
P16	113	38	32/32

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented.

Table 4 shows individual participants' performances in the final experimental conditions that sought to establish antecedent control of relating relational networks (Phase 3, analogous to Phase 5 in Experiment 1). All seven participants kept responding consistently with the Phase 2 training; on subphase 3.2, the antecedent control of S1 and S2 over relating relational networks was successfully established for four of seven participants, requiring between 36–109 trials to meet the mastery criterion; P11, P13, and P16 were dismissed from the experiment for not achieving the mastery criterion after 256 trials. The remaining four participants produced the predicted performances in Test 1 with a minimum of 31 correct responses in 32 trials. During baseline reversal, all four participants reached the mastery criterion within 17–108 training trials. In the final test, all four participants again produced the predicted performances.

In Experiment 2, four of seven participants failed to demonstrate antecedent control over the relating of relational networks, in contrast to only one participant who failed in Experiment 1. As noted previously, one possible explanation for the difference is that when the

TABLE 4 Results of Phase 3: Establishing antecedent control of relating relational networks (Experiment 2)

Participants	3.1 Baseline	3.2 S1 as S+ and S2 as S-	3.3 Test 1	3.4 S1 as S- and S2 as S+	3.5 Test 2
P9	15/32	109	31/32	47	32/32
P10	16/32	47	32/32	108	26/32
P11	14/32	-	-	-	-
P12	16/32	81	32/32	75	31/32
P13	16/32	-	-	-	-
P15	17/32	36	32/32	17	31/32
P16	15/32	-	-	-	-

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented. The symbol "-" in the table indicates that the participant in question did not reach the mastery criterion in the previous phase and was thus excluded from the study.

relational functions of contextual stimuli are established preexperimentally, there may be subtle differences in the learning histories of the participants that interact, in some unknown way, with the demands of the tasks presented during the experiment. One method for reducing such unknown differences would be to pretrain the "real" words in the same way that the contextual cues were trained in Experiment 1. This was the purpose of Experiment 3.

EXPERIMENT 3

Experiment 3 was similar to Experiment 1, except the Portuguese equivalent to "it's the same as" and "it's the opposite of" were employed as contextual cues *and* were pretrained in a manner similar to that employed in Phases 1 and 2 from Experiment 1.

Method

Participants

Eight undergraduate students (five female and three male), attending different universities in the city of São Paulo, volunteered to take part in the study. The participants were aged between 20 and 28 years and were recruited through personal contacts from a variety of degree programs, including psychology ($n = 3$). They received no payment or compensation for their participation.

Materials

The materials, setting, and stimuli were the same as those employed in Experiment 2.

Procedure

The procedure for Experiment 3 was similar to that for Experiment 1, except the two contextual cues were the Portuguese phrases "it's the same as" and "it's the opposite of."

Results and discussion

The results of the first two experimental phases are summarized in Table 5. Similar to Experiments 1 and 2, the results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented. All participants rapidly reached the mastery criterion in both nonarbitrary (25–76 trials needed) and arbitrary (24–70 trials needed) same/opposite pretraining and performed successfully in the corresponding testing phase. Likewise, all participants reached the mastery criterion in the direct function training. All participants then completed the relating relational networks phase within a range of 74 to 195 trials and produced the predicted performances in the testing phase, with a maximum of one incorrect response in 32 testing trials.

Individual participants' performances in the final experimental conditions are displayed in Table 6. All eight participants kept responding consistently with Phase 4 (Phase 5, baseline); when S1 functioned as S+ and S2 functioned as S-, antecedent control was successfully established for seven of eight participants, requiring between 14–102 trials to meet the mastery criterion; P18 was dismissed from the experiment for not achieving the mastery criterion after 256 trials. Six of seven participants produced the predicted performances in Test 1. The exception was P24, who responded correctly in 24 of 32 trials. During baseline reversal, all the remaining participants reached the mastery criterion within 13–93

TABLE 5 Results during Phases 1 to 4 (Experiment 3)

Part	Phase 1.1 Same/opposite nonarbitrary pretraining	Phase 1.2 Same/opposite nonarbitrary test	Phase 2.1 Same/opposite arbitrary pretraining	Phase 2.2 Same/opposite arbitrary test	Phase 3 Direct function training	Phase 4.1 Relating relational networks training	Phase 4.2 Relating relational networks test
P17	31	72/72	33	71/72	89	27	32/32
P18	47	72/72	24	72/72	91	102	32/32
P19	75	71/72	30	72/72	143	26	31/32
P20	54	72/72	73	72/72	97	61	31/32
P21	30	72/72	33	72/72	176	25	31/32
P22	76	70/72	24	72/72	74	24	32/32
P23	25	71/72	28	69/72	195	42	31/32
P24	25	72/72	24	72/72	85	48	32/32

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented.

TABLE 6 Results of Phase 5: Establishing antecedent control of relating relational networks (Experiment 3)

Participants	5.1 Baseline	5.2 S1 as S+ and S2 as S-	5.3 Test 1	5.4 S1 as S- and S2 as S+	5.5 Test 2
P17	16/32	84	32/32	13	32/32
P18	18/32	-	-	-	-
P19	16/32	14	31/32	15	32/32
P20	16/32	53	32/32	21	32/32
P21	16/32	82	32/32	36	31/32
P22	16/32	69	24/32	93	31/32
P23	15/32	102	31/32	36	32/32
P24	16/32	43	32/32	15	32/32

Note. The results for the training phases present the number of trials to reach the mastery criterion; for testing phases, the number of correct responses per number of test trials is presented. The symbol "-" in the table indicates that the participant in question did not reach the mastery criterion in the previous phase and was thus excluded from the study.

training trials. In the final test, all participants produced the predicted performances.

GENERAL DISCUSSION

The present study sought to train and test relating within and across relational networks and establish antecedent control. As far as we know, this was the first laboratory demonstration of its kind. The study showed relating within and across relational networks, and the networks were composed largely of novel arbitrary stimuli. Thus, the basic experimental analysis of relating relational networks was successfully modeled in the current study. Nevertheless, it is important to note that the two networks were generated initially from preexperimentally established networks in that two number sequences were employed, "1234" and "6789." Critically, the sequential properties of these networks were likely learned prior to the experiment (in the natural language environment). Perhaps, therefore, future studies could attempt to replicate the current findings but establish two separate networks using contextual cues for "before" and "after" to establish the relational networks (e.g., O'Hora et al., 2004, 2014). There is little reason to suspect that extending the experimental model in this way would not be possible (given the compelling findings reported by O'Hora et al.), but it does remain a potentially important goal for future studies in this area.

An interesting finding that emerged in the current study was that antecedent control by the contextual cues failed to develop for four of eight participants in Experiment 2 despite the use of natural language words in the place of pretrained pseudowords used in Experiment 1. Intuitively, it might be assumed that natural language stimuli should have produced the most reliable results, given the extensive behavioral histories involved in establishing the stimulus control for such stimuli. On balance, and as noted previously, it is perhaps worth recognizing that behavioral histories in the preexperimental natural environment likely differ somewhat across individual participants. For example, the way in which the term "opposite" is employed in natural language may not be particularly precise. In particular, the concept of opposite may be used to refer to the relation between two extreme points on a specific continuum, such as hot versus cold, with warm at a midpoint between the two extremes; opposite might also be used to refer to the relation between two points without any implied midpoint along a continuum. For example, it would be entirely acceptable to say that John sat opposite to Mary at a table; in this case there is no obvious relational continuum, so opposite may be seen as referring to a type of spatial relation (between John and Mary).

In light of this argument, it may be that the "meaning" or precise stimulus control afforded by the term opposite (in Experiment 2) differed in some subtle but definite ways when it was applied to 1 versus 4, rather than 2 versus 3. In the first instance, the relation may be seen as involving a continuum with 2 and 3 in the middle, but in the latter case the opposite relation between 2 and 3 seemingly involved no midpoint. Thus, when natural-language words are used to control behavior in an experimental context, it is possible that such subtle differences may produce behavioral outcomes that are not readily predicted. In the context of the current argument, perhaps some participants failed to respond to the relation between 2 and 3 as opposite if they understood the term to mean a relation between two extreme points along a specific continuum. Such an outcome would be less likely, however, when the critical relational pretraining is provided within the experiment. Indeed, when this pretraining is provided with natural-language stimuli (as in Experiment 3), it may serve to establish the precise relational control that the experimenter is seeking to establish. At a broader level, the current findings highlight that the relational pretraining that is often involved in RFT studies may be essential in establishing the predicted stimulus control.

At this point it should be recognized that the differences observed across Experiments 2 and 3 may have been somewhat random rather than systematic, particularly given the low number of participants involved. For example, differences across participants in different experiments may have been based, to some extent, on extraneous variables such as time of recruitment. Perhaps future research could pursue this line of inquiry.

Another potential limitation is that the relating of relational networks in the current study might be interpreted as involving mutually entailed opposition relations (i.e., 1–9, 2–8, 3–7, and 4–6). Informally, this could be described as "'Image 1 is the same as press 1, Image 1 is the opposite of press 9, press 9 is the same as Image 9, so Image 1 is the opposite of Image 9." That is, the relations within the networks may have been irrelevant, thus not definitively showing the relating of relational networks. On balance, it seems unlikely that verbally sophisticated adult participants would fail to respond to the number sequences employed in the current study, including their nonarbitrary alignment at the top of the keyboard, as simply involving mutually entailed relations. Note also that the number sequence on the keyboard was also separated arbitrarily and nonarbitrarily by the absence of the number 5, thus providing both an arbitrary and nonarbitrary cue separating the two networks. Nonetheless, it is important to recognize this potential limitation to the current study and future research may work to address this issue. For example, if comparison relations were established ($1 < 2 < 3 < 4$ and $6 < 7 < 8 < 9$) and if only 1 opposite 9 and 2 opposite 8 were trained and the remaining 3–7 and 4–6 were derived, that may provide more robust evidence for the relating of the relational networks. Ideally, however, such a study would involve employing completely arbitrary stimuli rather than real-world number sequences. Recognizing this potential limitation to the current study is indeed instructive in that it highlights the challenges going forward in attempting to develop experimental paradigms for analyzing the relating of relational networks.

In the current study, the relating of relational networks involved relating across two networks. This type of complex relational responding has received limited attention in the basic lab-based RFT research literature. At present, it remains unclear whether such relating between two networks should be described as mutually entailed network relating, and if so, whether relating across three or more relational networks would be described as combinatorially entailed network relating. Modeling such relational networking experimentally may involve a preparation similar to that of the current study but with three relational networks rather than two—for example, one network comprised again of numbers from 1–4, another again of 6–9 (as in the current study), and a third network comprised of 11–14. In this case, the number 1 in the first network could again be entailed as opposite to the number 9 in the second network but with the number 9 then being entailed as opposite to 11 in the third network. A test for combinatorial entailment across these three relational networks may then involve determining whether the numbers 1 and 11 were derived as same rather than opposite. Indeed, it seems important that RFT researchers, going forward, conduct more of these kinds of increasingly complex experimental analyses if they wish to pursue an increasingly sophisticated behavior-analytic account of human language and cognition.

Pursuing more sophisticated analyses may be important in terms of developing experimental analogues of important language abilities that are routinely taught in educational contexts. For example, even children learning to read simple stories will often be asked to compare and contrast basic narratives. Consider a child's story in which two families go on vacation. One family takes their pet dog, and the other takes their pet cat. The child may then be asked how the two families are similar and different. This may involve the child relating the two as similar on the basis of both taking a vacation but distinct in terms of the pet that accompanied them (i.e., dog vs. cat). Thus, even a simple educational task such as this may be conceptualized as involving the relating of relational networks.

Before concluding, the role of verbal mediation in the observed experimental performances might also be considered. We would certainly agree that participants likely engaged in large amounts of "self-talk" during the experiment. Furthermore, there is ample evidence that participants engage in relevant self-talk when exposed to training and testing procedures for derived relational responding (e.g., see Wulfert et al., 1991). From a behavior-analytic perspective, however, it would be a mistake to place the full burden of explanation for key-pressing responses on such self-talk because it involves appealing to a behavior–behavior relation (Hayes & Brownstein, 1986). Indeed, from the functional-analytic perspective of RFT, the key pressing and the self-talk would typically be considered a functional response unit unless specific contextual variables were used to separate the two topographies. With that said, future research might employ the methods developed by Wulfert et al. for studying self-talk (during the formation of equivalence classes) to experimental analyses of the relating of relational networks. Once again, however, the analysis of self-talk alone would not be sufficiently explanatory from a behavior-analytic perspective without analyzing the contextual variables that give rise to that self-talk and its relation to other response topographies, such as key pressing.

In closing, we argue that the complexity of the relational responding observed in the current study supports the call for a more field-like analysis of complex relational responding (Barnes-Holmes et al., 2020, 2021; Barnes-Holmes & Harte, 2022). Recent studies that have attempted to develop RFT analyses of performances produced on tasks that require rapid and accurate responding in accordance with relatively simple relational networks have highlighted the need to focus on the complex interactions among the different functional properties of that network (see Barnes-Holmes & Harte, 2022, for a recent summary of this work). The current findings also indicate that relational responding can become increasingly complex with multiple relational elements combining to produce a particular response—responding to two separate networks based on sequence relations and then relating those sequences across networks in terms of "same" versus "opposite" relations. Presumably, these are the types of relational responses that verbally sophisticated individuals produce repeatedly during their day-to-day lives, and a more complete science of behavior will need to develop a coherent and systematic account of this behavior going forward.

FUNDING INFORMATION

The present research was supported by the São Paulo Research Foundation (FAPESP Grants 2016/05935–6, 2017/10037–0, 2008/57705–8, 2019/24210–0) and by the Brazilian National Research Council (CNPq, Grants 573972/2008–7 and 465686/2014–1). The present study is also part of the research program of the Instituto Nacional de Ciência e Tecnologia sobre Comportamento, Cognição e Ensino (INCT-ECCE).

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflict of interest.

ETHICS APPROVAL

All procedures performed in the present research were previously approved by the Brazilian platform for ethical committees, Plataforma Brasil, the Human Research Ethics Committee (protocol CAAE 67865517.7.0000.5482).

ORCID

Colin Harte https://orcid.org/0000-0003-2320-2361

REFERENCES

Barnes, D., Hegarty, N., & Smeets, P. (1997). Relating equivalence relations to equivalence relations: A relational framing model of complex human functioning. *The Analysis of Verbal Behavior*, *14* (1), 57–83. https://doi.org/10.1007/BF03392916

Barnes-Holmes, D., & Harte, C. (2022). Relational frame theory 20 years on: The Odysseus voyage and beyond. *Journal of the Experimental Analysis of Behavior*, *117*(2), 240–266. https://doi.org/10.1002/jeab.733

Barnes-Holmes, D., Barnes-Holmes, Y., Luciano, C., & McEnteggart, C. (2017). From IRAP and REC model to a multidimensional multi-level framework for analysing the dynamics of arbitrarily applicable relational responding. *Journal of Contextual Behavioral Science*, *6*(4), 473–483. https://doi.org/10.1016/j.jcbs.2017.08.001

Barnes-Holmes, D., Barnes-Holmes, Y., & McEnteggart, C. (2020). Updating RFT (more field than frame) and its implications for process-based therapy. *The Psychological Record*, *70*(4), 605–624. https://doi.org/10.1007/s40732-019-00372-3

Barnes-Holmes, D., Barnes-Holmes, Y., McEnteggart, C., & Harte, C. (2021). Back to the future with an up-dated version of RFT: More field than frame? *Perspectivas em Análise do Comportamento*, *12*(1), 33–51. https://doi.org/10.18761/PAC.2021.v12RFT.03

Barnes-Holmes, D., O'Hora, D., Hayes, S. C., Bisset, R. T., & Lyddy, F. (2001). Understanding and verbal regulation. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.), *Relational frame theory: A post-Skinnerian account of human language and cognition* (pp. 103–117). Plenum.

Dougher, M. J., Hamilton, D., Fink, B., & Harrington, J. (2007). Transformation of the discriminative and eliciting functions of generalized relational stimuli. *Journal of the Experimental Analysis of Behavior*, *88*(2), 179–197. https://doi.org/10.1901/jeab.2007.45-05

Dymond, S., & Roche, B. (2012). *Advances in relational frame theory: Research and application*. New Harbinger.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory: A post-Skinnerian account of human language and cognition*. Plenum.

Hayes, S. C., & Brownstein, A. J. (1986). Mentalism, behavior-behavior relations, and a behavior-analytic view of the purposes of science. *The Behavior Analyst*, *9*(2), 175–190. https://doi.org/10.1007/BF03391944

Hughes, S., & Barnes-Holmes, D. (2016). Relational frame theory: The basic account. In R. D. Zettle, S. C. Hayes, D. Barnes-Holmes, & A. Biglan (Eds.), *The Wiley handbook of contextual behavioral science* (pp. 129–178). John Wiley & Sons.

O'Hora, D., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2004). Derived relational networks and control by novel instructions: A possible model of generative verbal responding. *The Psychological Record*, *54*(3), 437–460. https://doi.org/10.1007/BF03395484

O'Hora, D., Barnes-Holmes, D., & Stewart, I. (2014). Antecedent and consequential control of derived instruction-following. *Journal of the Experimental Analysis of Behavior*, *102*(1), 66–85. https://doi.org/10.1002/jeab.95

Steele, D. L., & Hayes, S. C. (1991). Stimulus equivalence and arbitrarily applicable relational responding. *Journal of the Experimental Analysis of Behavior*, *56*(3), 519–555. https://doi.org/10.1901/jeab.1991.56-519

Stewart, I., & Barnes-Holmes, D. (2004). Relational frame theory and analogical reasoning: Empirical investigations. *International Journal of Psychology and Psychological Therapy*, *4*(2), 241–262.

Wulfert, E., Dougher, M. J., & Greenway, D. E. (1991). Protocol analysis of the correspondence of verbal behavior and equivalence class formation. *Journal of the Experimental Analysis of Behavior*, *56*(3), 489–504. https://doi.org/10.1901/jeab.1991.56-489

Zapparoli, H. B., Marin, R., & Harte, C. (2021). Rule-governed behavior: An ongoing RFT-based operant analysis. *Perspectivas em Análise do Comportamento*, *12*(1), 197–213. https://doi.org/10.18761/PAC.2021.v12.RFT.09

How to cite this article: Gomes, C. T., Perez, W. F., Barnes-Holmes, D., & Harte, C. (2023). Relating relational networks: An initial experimental analysis. *Journal of the Experimental Analysis of Behavior*, 1–13. https://doi.org/10.1002/jeab.854